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# Reporting the Natural Environmental Hazards occurrences and fatalities over the last century

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## **Abstract**

This paper presents the occurrences and fatalities of natural environmental hazards drawing an initial picture of concentration, if there is any. For that reason, the authors use aggregate regional tables as well as map visualizations created in R- studio. As it is shown, there appears to be a space concentration on the natural environmental hazards that need to be deeply examined with the use of advanced econometric techniques.

**Keywords:** Biological, climatological, extra-terrestrial, geophysical, hydrological, meteorological, risk, hazard, disaster, economic damage

**JEL codes:** C63; D62; H12; I31; Q50.

## **Acknowledgements**

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## **1. Introduction**

The environment is a fragile scenery that can dramatically be changed in just a moment. This change can be caused either by natural factors or human activities. The events caused by natural factors are called Natural environmental events while those caused by human activities are called Technological environmental or man-made events. At the same time, these changes can be insignificant or can be highly significant which can transform existing scenery into something completely different. These significant changes most of the time tend to be disastrous leading to notable losses, both economic and human losses, either direct or indirect. Being focused on the natural environmental cases we should mention that some of the most well-known significant and disastrous natural events are the earthquakes, the volcanic activities, and the tsunamis. What is known about those events is that when they occur, people may count huge economic losses as well as a great number of fatalities. What is not well known though is that those catastrophic events may possibly have advantages which will avail the next generation or even the descendant thousands of years after the occurrence.

Going back in time, we shall bring to our minds events from all three categories already mentioned that are well known and recognized as historical milestones. In 1600 BC a volcanic eruption in the Greek Island Thera, nowadays known as Santorini, has wrecked half of the existing island while at the same time led to a tsunami that traveled through the Aegean Archipelagos to Crete causing one of the greatest ancient Greek disasters, the devastation of the Minoan Civilization. A similar event occurred in the neighbor country, Italy, started in AD 62 with a significant earthquake in Pompeii which was the portent of the volcanic eruption of Mount Vesuvius in AD 79 which buried the whole Pompeii under the lava flow. Those geophysical events have devastated civilizations and hold a place in European, and not only, history as some of the most catastrophic moments. However, without ignoring the

incalculable damages that have been caused, these historical milestones meant to be some of the high earning sources for those regions, if not the whole country.

Nowadays, Santorini is one of the most famous tourist attraction all over the world and there is a vast majority of people visiting the Greek island having as a purpose to visit the, still active, volcano. Minoan historical sightseeing tends to be as famous as the Santorini's volcano, attracting visitors both from the inside of the country and abroad. Regarding the Italian city, Pompeii, nowadays, is one of the most visited historical sightseeing where people can see the incredible findings of the excavations which reveal that last moment before the advent of the lava which charred the settlement.

The purpose of this paper is to report graphical and statistical results based on natural environmental hazards occurred over the last 117 years (1900-2016) as they have been recorded by the EM-DAT (2017). The graphical representation includes map visualizations techniques while the numerical representation includes regional aggregated values over the last century. Section 2 presents the full list of natural environmental hazards as it is given by the EM-DAT (2017), while section 3 analyzes the methodology used in order to obtain the results that are discussed in section 4. Finally, section 5 gives the general conclusion and proposals for further research.<sup>1</sup>

## **2. List of Natural Environmental Hazards**

When the field of research is so complicated a great variety of terms and definitions are created, based on the specific impact we investigate. The scientific field of environmental hazards, either natural or technological, contains a detailed list of terms and definitions. Although each term has a specific and detailed explanation for each precise meaning, the

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<sup>1</sup> It may be a starting point in exploring among others the effect of growth on the environment (Halkos, 1996, 2003, 2006; Perrings and Halkos, 2015), on organizations and employees (Halkos and Bousinakis, 2012) and on environmental efficiency and performance (Halkos and Zisiadou, 2018; Halkos and Tzeremes, 2009).

majority of people tend to be confused and not use the appropriate term. The most common example is the triplet of the words “hazard”, “disaster” and “risk”. These three words describe different conditions, however, most of the people tend to use them for the same condition due to the fact of assuming them as synonyms.

The case of natural environmental hazards is divided into six subgroups: biological, climatological, extra-terrestrial, geophysical, hydrological and meteorological. Each subgroup is then divided into types and subtypes based on the common factors of occurrence. Table 1 presents all different subtypes of natural environmental hazards that are listed under the appropriate type, and subgroup.

### 3. Methodology and Data

A full dataset of all types of environmental hazard described above for a 117-year time span is being used in an initial attempt to point out the high frequency and the low frequency areas based on statistical and graphical presentation techniques. More specifically, the EM-DAT (2017) provides information from 1900 till 2016<sup>2</sup>. Every type of hazard is listed per year for each country and is followed by information regarding the occurrence per year as well as the fatalities and the economic damages.

The regional results presented are calculated by regional summations. For the variables: deaths, injured, affected, homeless, total affected and economic damage, the reported results have been weighted using the number of occurrence. More specifically, the formula used for the weightings is the following:

$$\text{reported deaths} = \frac{\text{Actual number of deaths}}{\text{Number of occurrence}}$$

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<sup>2</sup> <http://www.emdat.be/database> Accessed: 05 May 2017

**Table 1:** Natural Hazard Classification (based on CRED – EM-DAT)

	Subgroup		Type		Subtype
1	Biological	1	Animal Accident	1	--- <sup>3</sup>
		2	Epidemic	2	---
				3	Bacterial Disease
				4	Parasitic Disease
				5	Viral Disease
		3	Insect Infestation	6	---
				7	Grasshopper
				8	Locust
2	Climatological	4	Drought	9	Drought
		5	Wildfire	10	---
				11	Forest Fire
				12	Land Fire
3	Extra-terrestrial	6	Impact	13	Impact
4	Geophysical	7	Earthquakes	14	---
				15	Ground Movement
				16	Tsunami
		8	Mass Movement (dry)	17	---
				18	Avalanche
				19	Landslide
				20	Rockfall
				21	Subsidence
		9	Volcanic Activity	22	---
				23	Ash fall
				24	Lava flow
5	Hydrological	10	Flood	25	---
				26	Coastal Flood
				27	Flash Flood
				28	Riverine Flood
		11	Landslide	29	---
				30	Avalanche
				31	Landslide
				32	Rockfall
				33	Subsidence
6	Meteorological	12	Extreme Temperature	34	Cold Wave
				35	Hot Wave
				36	Severe Winter Conditions
		13	Fog	37	---
		14	Storm	38	---
				39	Convective Storm
				40	Extra-tropical Storm
				41	Tropical Cyclone

<sup>3</sup> ---: unidentified cause

The maps which are presented on this paper are created using the R-studio software. The packages that have been used for the map visualization are: “rworldmap”, “RColorBrewer”, “ncdf.tools”, “classInt”. After creating the weighted variables, we inserted the final dataset:

```
> library(readxl)
> data <- read_excel("File/data.xlsx")
View(data)
> library("rworldmap",
lib.loc="/Library/Frameworks/R.framework/Versions/3.3/Resources/library")
>library("RColorBrewer",
lib.loc="/Library/Frameworks/R.framework/Versions/3.3/Resources/library")
> library("ncdf.tools",
lib.loc="/Library/Frameworks/R.framework/Versions/3.3/Resources/library")
> library("classInt",
lib.loc="/Library/Frameworks/R.framework/Versions/3.3/Resources/library")
> attach(data)
> data<-data
```

The next procedure is to create the group of analysis which will afterwards be used on the map process. The method used to identify the country of origin for each event is the ISO code, while the color palette chosen is the “heat map color” reporting the low values with yellow and the high values with red color. Missing, or non-affected countries are reported with grey color.

The same procedure is followed for all five natural environmental hazards, while the extra-terrestrial subgroup has been excluded due to the fact that only one events has occurred since 1900.

```

> group<-joinCountryData2Map(data,joinCode = "ISO3",nameJoinColumn =
"ISO",mapResolution = "coarse",verbose = TRUE)

> map<-mapCountryData(group,nameColumnToPlot = "Occurrence",catMethod =
"fixedWidth",numCats = 200,addLegend = TRUE,colourPalette = "heat",oceanCol =
"lightblue",missingCountryCol = "grey",mapTitle = "Meteorological Occurrence")

> map<-mapCountryData(group,nameColumnToPlot = "Total_deaths",catMethod =
"fixedWidth",numCats = 200,addLegend = TRUE,colourPalette = "heat",oceanCol =
"lightblue",missingCountryCol = "grey",mapTitle = "Meteorological Total Deaths")

> map<-mapCountryData(group,nameColumnToPlot = "Injured",catMethod =
"fixedWidth",numCats = 200,addLegend = TRUE,colourPalette = "heat",oceanCol =
"lightblue",missingCountryCol = "grey",mapTitle = "Meteorological Injured")

> map<-mapCountryData(group,nameColumnToPlot = "Affected",catMethod =
"fixedWidth",numCats = 200,addLegend = TRUE,colourPalette = "heat",oceanCol =
"lightblue",missingCountryCol = "grey",mapTitle = "Meteorological Affected")

> map<-mapCountryData(group,nameColumnToPlot = "Homeless",catMethod =
"fixedWidth",numCats = 200,addLegend = TRUE,colourPalette = "heat",oceanCol =
"lightblue",missingCountryCol = "grey",mapTitle = "Meteorological Homeless")

> map<-mapCountryData(group,nameColumnToPlot = "Total_affected",catMethod =
"fixedWidth",numCats = 200,addLegend = TRUE,colourPalette = "heat",oceanCol =
"lightblue",missingCountryCol = "grey",mapTitle = "Meteorological Total Affected")

> map<-mapCountryData(group,nameColumnToPlot = "Total_damage",catMethod =
"fixedWidth",numCats = 200,addLegend = TRUE,colourPalette = "heat",oceanCol =
"lightblue",missingCountryCol = "grey",mapTitle = "Meteorological Total Damage ('000$)")

```

#### 4. Results and Discussion

Before we start the sub-sectional analysis, it is important to have a general picture of the data we used in our analysis. Therefore, we created bar graphs that present the aggregated values for each under-examination variable including all six subgroups. Based on the bar graph the most occurred natural environmental hazard is the biological subgroup (Figure 1). Moreover, biological hazards have caused the greatest number of deaths over the last century (Figure 2). Based on Figure 3, meteorological hazards are responsible for the highest value of homeless people over the last 117 years. At the same time, Figure 4 presents that hydrological hazards can lead to the most affected people in a 117- year time span, as well as



to the most homeless people as it can be seen in Figure 5. Finally, the greatest economic damage has derived by the meteorological hazards (Figure 6).

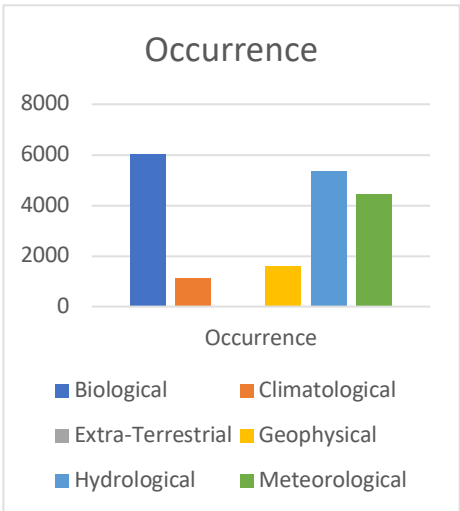


Figure 1: Occurrence per Environmental Hazard

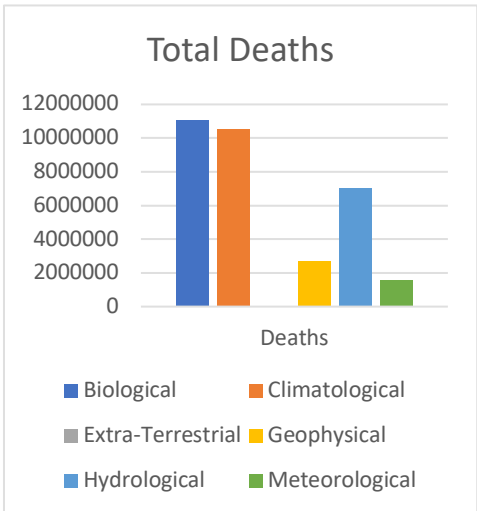


Figure 2: Total Deaths per Environmental Hazard

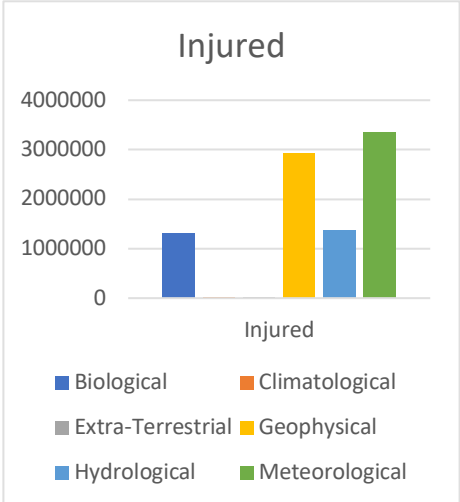


Figure 3: Injured per Environmental Hazard

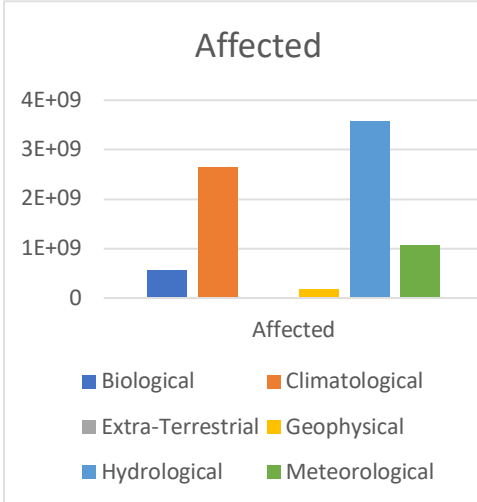


Figure 4: Affected per Environmental Hazard

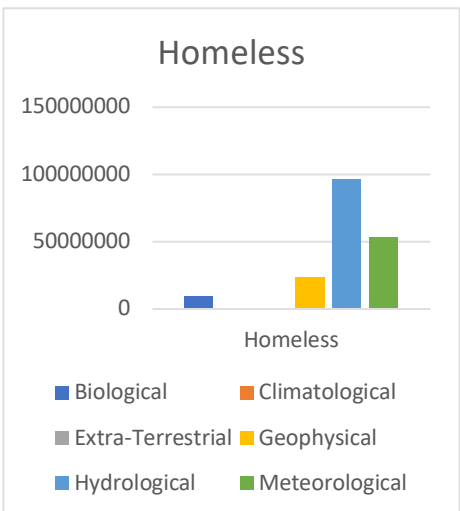


Figure 5: Homeless per Environmental Hazard

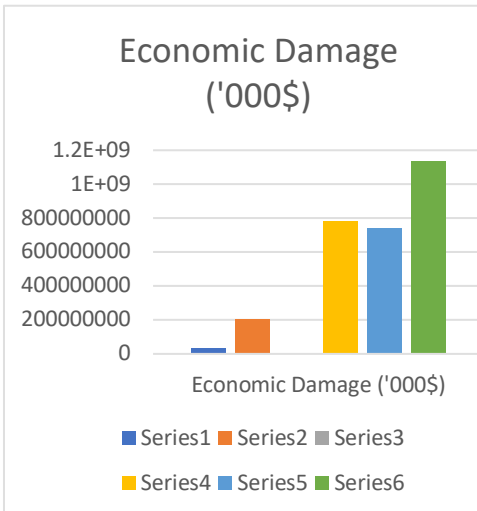


Figure 6: Economic Damage ('000\$)s per Environmental Hazard

#### *4.1 Biological Hazards*

Moving forward, we are going to present the regional results for each subtype of all natural hazards. Starting with the biological hazards, the regional occurrence and fatality tables are presented in Appendix I (Tables 1-3). There is only 1 animal accident over the last century in Western Africa causing 12 deaths and affecting 5 people in total. Compared to the animal accidents, there are recorded 1,391 epidemics with a total of 9.5 million deaths and over 46 million total affected people. Finally, there are 4,619 parasitic disease events over the last century, leading to almost 1.5 million deaths.

Based both on the tables in Appendix I (1-3) and map representations in Appendix II (1-6), the biological events are concentrated on the Least Developed Countries where the fatalities and economic damages are also higher.

#### *4.2 Climatological Hazards*

Moving forward, to the climatological hazards, the regional occurrence and fatality tables are presented in Appendix I (Tables 4-5). There are 721 drought events over the last century with the majority of them in Western Africa causing more than 10 million deaths and affecting almost 263 million people in total. Compared to droughts, there are recorded 401 wildfires with a total of 3,792 deaths and over 6 million total affected people.

Based both on the tables in Appendix I (4-5) and map representations in Appendix II (7-12), the climatological events are concentrated on the African and American Regions where the fatalities and economic damages are also higher.

#### *4.3 Geophysical Hazards*

The next subgroup is geophysical hazards, where the regional occurrence and fatality tables are presented in Appendix I (Tables 6-10). There are 1,316 earthquake events over the last century with the majority of them in Eastern and Southern Asia causing more than 2 million deaths and affecting over 192 million people in total. Compared to earthquakes, there

are recorded only 56 mass movements (dry) with a total of 5,030 deaths and over 211 million economic damage. Finally, there are 240 volcanic activity events over the last century, leading to almost 100 thousand deaths.

Based both on the tables in Appendix I (6-10) and map representations in Appendix II (13-18), the geophysical events are concentrated on the Asian Regions where the fatalities and economic damages are also higher.

#### *4.4 Hydrological Hazards*

The next subgroup is hydrological hazards, where the regional occurrence and fatality tables are presented in Appendix I (Tables 11-12). There are 4,681 flood events over the last century with the majority of them in South-Eastern and Southern Asia causing almost 7 million deaths and affecting over 3 billion people in total. Compared to floods, there are recorded only 673 landslides with a total of 62,658 deaths and over 9 billion economic damage.

Based both on the tables in Appendix I (11-12) and map representations in Appendix II (19-24), the biological events are concentrated on Asian Regions Countries where the fatalities and economic damages are also higher.

#### *4.5 Meteorological Hazards*

Last but not least is the meteorological hazards, where the regional occurrence and fatality tables are presented in Appendix I (Tables 13-15). There are 533 extreme temperature over the last century with the majority of them in Southern Asia causing almost 182 thousand deaths and affecting over 101 million people in total. Compared to extreme temperature, there are recorded 3,919 storms with a total of 1.4 million deaths and over 107 billion economic damage. Finally, fog is the subtype that records, similarly to animal accident and impact (extra-terrestrial hazards) only 1 event over the last century with a total of 4 thousand deaths and no other fatalities or losses.

Based both on the tables in Appendix I (13-15) and map representations in Appendix II (25-30), the biological events are concentrated on Asian Regions Countries where the fatalities and economic damages are also higher.

## **5. Conclusions**

The purpose of this paper is to report the graphical and statistical results based on natural environmental hazards occurred over the last 117 years (1900-2016) as they have been recored by the EM-DAT (2017). As it has been seen, there is a space concentration regarding the natural environmental hazards. Although we cannot rely on graphical and statistical representations in order to draw research conclusions, we can propose further research based on the advanced econometric approaches proposed by literature review. Moreover, as it has already been mentioned, this work will be used as a supplementary guide to further research.

## References

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## R-studio Package Guides

classInt: <https://cran.r-project.org/web/packages/classInt/classInt.pdf>

ncdf.tools: <https://cran.r-project.org/web/packages/ncdf.tools/ncdf.tools.pdf>

RColorBrewer: <https://cran.r-project.org/web/packages/RColorBrewer/RColorBrewer.pdf>

rworldmap: <https://cran.r-project.org/web/packages/rworldmap/rworldmap.pdf>

## Appendix I

**Table 1:** Animal Accident - Regional Results

Animal Accident								
Continent	Region	Occurrence	Deaths	Injured	Affected	Homeless	Total Affected	Economic Damage ('000\$)
Africa	Eastern Africa	0	0	0	0	0	0	0
Africa	Middle Africa	0	0	0	0	0	0	0
Africa	Northern Africa	0	0	0	0	0	0	0
Africa	Southern Africa	0	0	0	0	0	0	0
Africa	Western Africa	1	12	0	5	0	5	0
Americas	Caribbean	0	0	0	0	0	0	0
Americas	Central America	0	0	0	0	0	0	0
Americas	South America	0	0	0	0	0	0	0
Americas	Northern America	0	0	0	0	0	0	0
Asia	Central Asia	0	0	0	0	0	0	0
Asia	Eastern Asia	0	0	0	0	0	0	0
Asia	Southern Asia	0	0	0	0	0	0	0
Asia	South-Eastern Asia	0	0	0	0	0	0	0
Asia	Western Asia	0	0	0	0	0	0	0
Europe	Eastern Europe	0	0	0	0	0	0	0
Europe	Northern Europe	0	0	0	0	0	0	0
Europe	Southern Europe	0	0	0	0	0	0	0
Europe	Western Europe	0	0	0	0	0	0	0
Oceania	Australia & New Zealand	0	0	0	0	0	0	0
Oceania	Melanesia	0	0	0	0	0	0	0
Oceania	Micronesia	0	0	0	0	0	0	0
Oceania	Polynesia	0	0	0	0	0	0	0
		<b>1</b>	<b>12</b>	<b>0</b>	<b>5</b>	<b>0</b>	<b>5</b>	<b>0</b>

**Table 2:** Epidemic - Regional Results

Epidemic								
Continent	Region	Occurrence	Deaths	Injured	Affected	Homeless	Total Affected	Economic Damage ('000\$)
Africa	Eastern Africa	289	248136	70326	10342992	0	10413318	0
Africa	Middle Africa	172	21517	6344	1032113	0	1038457	0
Africa	Northern Africa	44	19920	632	217069	0	217701	0
Africa	Southern Africa	23	1471	518	169811	0	170329	0
Africa	Western Africa	285	154786	64530	1180556	0	1245086	0
Americas	Caribbean	29	7594	277671	465524	0	743195	0
Americas	Central America	50	1550	15211	315468	0	330679	7
Americas	South America	76	15288	79725	2747931	0	2827656	0
Americas	Northern America	12	50879	0	2415620	0	2415620	0
Asia	Central Asia	12	261	141	25861	0	26002	0
Asia	Eastern Asia	27	1562080	185	2310019	0	2310204	0
Asia	Southern Asia	164	4957089	211	4209901	0	4210112	0
Asia	South-Eastern Asia	109	8963	124336	1295727	0	1420063	0
Asia	Western Asia	30	1069	2217	220987	0	223204	0
Europe	Eastern Europe	21	2500321	0	18172822	0	18172822	0
Europe	Northern Europe	9	73	0	2021	0	2021	0
Europe	Southern Europe	12	47	0	14071	0	14071	0
Europe	Western Europe	7	34	0	920	0	920	0
Oceania	Australia & New Zealand	3	6700	0	7	0	7	0
Oceania	Melanesia	10	451	372000	13408	0	385408	0
Oceania	Micronesia	3	42	0	4001	0	4001	0
Oceania	Polynesia	4	8	0	2867	0	2867	0
		<b>1391</b>	<b>9558279</b>	<b>1E+06</b>	<b>45159696</b>	<b>0</b>	<b>46173743</b>	<b>7</b>

**Table 3:** Insect Infestation - Regional Results

Insect Infestation								
Continent	Region	Occurrence	Deaths	Injured	Affected	Homeless	Total Affected	Economic Damage ('000\$)
Africa	Eastern Africa	1488	829839	97203	3,13E+08	3804253	316497020	6491319
Africa	Middle Africa	665	47076	21459	18512860	694000	19228319	140441
Africa	Northern Africa	749	218256	91429	39583840	2536817	42212086	17213105
Africa	Southern Africa	373	8821	9403	31449367	108815	31567585	6242251
Africa	Western Africa	1327	378658	79706	1,06E+08	2227247	108683662	1875341
Americas	Caribbean	0	0	0	0	0	0	0
Americas	Central America	0	0	0	0	0	0	0
Americas	South America	3	0	0	2000	0	2000	104000
Americas	Northern America	0	0	0	0	0	0	0
Asia	Central Asia	1	0	0	0	0	0	0
Asia	Eastern Asia	1	0	0	0	0	0	0
Asia	Southern Asia	3	0	0	0	0	0	0
Asia	South-Eastern Asia	3	0	0	200	0	200	925
Asia	Western Asia	3	0	0	0	0	0	0
Europe	Eastern Europe	1	0	0	0	0	0	0
Europe	Northern Europe	0	0	0	0	0	0	0
Europe	Southern Europe	0	0	0	0	0	0	0
Europe	Western Europe	0	0	0	0	0	0	0
Oceania	Australia & New Zealand	2	0	0	0	0	0	120000
Oceania	Melanesia	0	0	0	0	0	0	0
Oceania	Micronesia	0	0	0	0	0	0	0
Oceania	Polynesia	0	0	0	0	0	0	0
		<b>4619</b>	<b>1482650</b>	<b>299200</b>	<b>5,09E+08</b>	<b>9371132</b>	<b>518190872</b>	<b>32187382</b>



**Table 4: Drought - Regional Results**

<b>Drought</b>								
<b>Continent</b>	<b>Region</b>	<b>Occurrence</b>	<b>Deaths</b>	<b>Injured</b>	<b>Affected</b>	<b>Homeless</b>	<b>Total Affected</b>	<b>Economic Damage ('000\$)</b>
Africa	Eastern Africa	133	543561	0	249752253	0	249752253	371900
Africa	Middle Africa	26	3058	0	13779800	0	13779800	84500
Africa	Northern Africa	17	150000	0	27653400	0	27653400	900100
Africa	Southern Africa	35	500	0	27760115	0	27760115	3164739
Africa	Western Africa	98	170012	0	81814185	0	81814185	507354
Americas	Caribbean	29	0	0	8331762	0	8331762	197639
Americas	Central America	44	101	0	10369416	0	10369416	2313400
Americas	South America	69	76	500	89781203	3085	89784788	13285100
Americas	Northern America	36	27	273	741332	10635	752240	48959100
Asia	Central Asia	4	0	0	6400000	0	6400000	107000
Asia	Eastern Asia	50	3503534	0	542250000	0	542250000	32224420
Asia	Southern Asia	47	6150518	0	1477985000	0	1477985000	6165372
Asia	South-Eastern Asia	48	9348	0	62506716	0	62506716	2134472
Asia	Western Asia	16	60	77	5472700	20650	5493427	487000
Europe	Eastern Europe	17	0	0	5452000	20000	5472000	487000
Europe	Northern Europe	3	0	0	0	0	0	1030173
Europe	Southern Europe	17	0	0	9272575	0	9272575	16721136
Europe	Western Europe	5	0	0	0	0	0	1610000
Oceania	Australia & New Zealand	12	600	0	7080000	0	7080000	11496000
Oceania	Melanesia	9	84	0	3421835	0	3421835	90000
Oceania	Micronesia	3	0	0	119184	0	119184	0
Oceania	Polynesia	3	0	0	0	0	0	0
		<b>721</b>	<b>10531479</b>	<b>850</b>	<b>2629943476</b>	<b>54370</b>	<b>2629998696</b>	<b>142336405</b>

**Table 5: Wildfires - Regional Results**

		Wildfire						
Continent	Region	Occurrence	Deaths	Injured	Affected	Homeless	Total Affected	Economic Damage ('000\$)
Africa	Eastern Africa	3	49	28	0	3000	3028	0
Africa	Middle Africa	5	12	0	57088	3645	60733	0
Africa	Northern Africa	4	77	0	300	105	405	0
Africa	Southern Africa	10	130	530	2500	5850	8880	440000
Africa	Western Africa	8	10	200	6700	14093	20993	0
Americas	Caribbean	5	0	0	0	0	0	1000
Americas	Central America	14	110	0	18636	0	18636	171200
Americas	South America	31	111	604	310575	6217	317396	1080000
Americas	Northern America	99	1405	639	908916	50977	960532	27258100
Asia	Central Asia	1	0	0	8000	0	8000	0
Asia	Eastern Asia	45	292	303	65114	10635	76052	1932800
Asia	Southern Asia	7	94	0	0	54000	54000	11700
Asia	South-Eastern Asia	20	329	478	3502552	23000	3526030	10644000
Asia	Western Asia	10	60	77	20700	650	21427	315000
Europe	Eastern Europe	31	220	2345	110000	4005	116350	2340210
Europe	Northern Europe	0	0	0	0	0	0	0
Europe	Southern Europe	54	280	460	1173408	4537	1178405	10605421
Europe	Western Europe	13	112	161	6250	6	6417	10000
Oceania	Australia & New Zealand	39	501	1239	69444	20378	91061	3494394
Oceania	Melanesia	1	0	0	8000	0	8000	0
Oceania	Micronesia	0	0	0	0	0	0	0
Oceania	Polynesia	1	0	0	1000	0	1000	31650
		<b>401</b>	<b>3792</b>	<b>7064</b>	<b>6269183</b>	<b>201098</b>	<b>6477345</b>	<b>58335475</b>

**Table 6: Earthquake - Regional Results**

		<b>Earthquake</b>						
<b>Continent</b>	<b>Region</b>	<b>Occurrence</b>	<b>Deaths</b>	<b>Injured</b>	<b>Affected</b>	<b>Homeless</b>	<b>Total Affected</b>	<b>Economic Damage ('000\$)</b>
Africa	Eastern Africa	36	580	2637	219345	75335	297317	794570
Africa	Middle Africa	5	53	696	20615	1850	23161	7200
Africa	Northern Africa	32	20421	56693	611953	838409	1507055	11995929
Africa	Southern Africa	9	71	165	3285	0	3450	20000
Africa	Western Africa	2	292	1436	20000	0	21436	0
Americas	Caribbean	14	223971	300179	3498029	55	3798263	8075000
Americas	Central America	91	56628	163191	10545696	1932564	12641451	12138250
Americas	South America	137	156510	513319	16710374	2424945	19648638	41087886
Americas	Northern America	42	2914	13294	41714	20239	75247	41741670
Asia	Central Asia	22	189	954	264645	40597	306196	203500
Asia	Eastern Asia	235	1088029	840468	71998512	4958455	77797435	485145157
Asia	Southern Asia	222	435529	666853	37756462	8289975	46713290	30199743
Asia	South-Eastern Asia	157	218128	195250	13289350	1573191	15057791	14350304
Asia	Western Asia	94	91241	100423	6794405	1253890	8148718	27088073
Europe	Eastern Europe	58	160227	30055	1768633	970740	2769428	19431320
Europe	Northern Europe	5	1	8	4629	69	4706	84000
Europe	Southern Europe	93	118363	24335	2392148	402028	2818511	58629016
Europe	Western Europe	9	60	112	2650	200	2962	362000
Oceania	Australia & New Zealand	13	471	1726	643010	720	645456	25797344
Oceania	Melanesia	33	2751	1055	49428	18900	69383	10875
Oceania	Micronesia	1	0	71	0	0	71	120000
Oceania	Polynesia	6	197	342	13274	500	14116	134740
		<b>1316</b>	<b>2576626</b>	<b>3E+06</b>	<b>1,67E+08</b>	<b>2,3E+07</b>	<b>192364081</b>	<b>777416577</b>

**Table 7: Mass Movement (dry) - Regional Results**

<b>Mass Movement (dry)</b>								
<b>Continent</b>	<b>Region</b>	<b>Occurrence</b>	<b>Deaths</b>	<b>Injured</b>	<b>Affected</b>	<b>Homeless</b>	<b>Total Affected</b>	<b>Economic Damage ('000\$)</b>
Africa	Eastern Africa	1	13	0	0	0	0	0
Africa	Middle Africa	0	0	0	0	0	0	0
Africa	Northern Africa	3	163	72	300	625	997	0
Africa	Southern Africa	0	0	0	0	0	0	0
Africa	Western Africa	1	46	0	200	0	200	0
Americas	Caribbean	1	40	0	0	0	0	0
Americas	Central America	3	69	0	2037	991	3028	0
Americas	South America	6	2307	36	2250	125	2411	200000
Americas	Northern America	8	305	91	0	3500	3591	0
Asia	Central Asia	2	13	0	0	400	400	0
Asia	Eastern Asia	7	500	135	5000	340	5475	8000
Asia	Southern Asia	6	374	0	0	0	0	0
Asia	South-Eastern Asia	5	564	50	651	0	701	1000
Asia	Western Asia	2	281	69	1000	0	1069	0
Europe	Eastern Europe	6	205	6	10250	0	10256	2600
Europe	Northern Europe	0	0	0	0	0	0	0
Europe	Southern Europe	0	0	0	0	0	0	0
Europe	Western Europe	3	64	52	0	0	52	0
Oceania	Australia & New Zealand	0	0	0	0	0	0	0
Oceania	Melanesia	2	86	0	1000	0	1000	0
Oceania	Micronesia	0	0	0	0	0	0	0
Oceania	Polynesia	0	0	0	0	0	0	0
		<b>56</b>	<b>5030</b>	<b>511</b>	<b>22688</b>	<b>5981</b>	<b>29180</b>	<b>211600</b>

**Table 8: Volcanic Activity - Regional Results**

Volcanic Activity								
Continent	Region	Occurrence	Deaths	Injured	Affected	Homeless	Total Affected	Economic Damage ('000\$)
Africa	Eastern Africa	10	88	0	316000	5200	321200	0
Africa	Middle Africa	6	2130	837	12500	170510	183847	9000
Africa	Northern Africa	0	0	0	0	0	0	0
Africa	Southern Africa	0	0	0	0	0	0	0
Africa	Western Africa	2	0	6	3800	5000	8806	0
Americas	Caribbean	6	31567	3	97000	200	97203	0
Americas	Central America	37	13227	810	666916	18880	686606	124722
Americas	South America	40	22942	5026	1682653	9600	1697279	1879975
Americas	Northern America	1	90	0	0	2500	2500	860000
Asia	Central Asia	0	0	0	0	0	0	0
Asia	Eastern Asia	16	578	89	98859	1100	100048	132000
Asia	Southern Asia	0	0	0	0	0	0	0
Asia	South-Eastern Asia	81	21306	4919	3009261	102800	3116980	762351
Asia	Western Asia	1	6	15	0	0	15	0
Europe	Eastern Europe	1	0	0	0	0	0	0
Europe	Northern Europe	5	0	0	5200	0	5200	41200
Europe	Southern Europe	9	767	24	20200	14000	34224	11100
Europe	Western Europe	0	0	0	0	0	0	0
Oceania	Australia & New Zealand	2	150	0	70	0	70	0
Oceania	Melanesia	21	3515	31	212679	46000	258710	110000
Oceania	Micronesia	1	0	0	0	0	0	0
Oceania	Polynesia	1	0	0	2500	0	2500	0
		<b>240</b>	<b>96366</b>	<b>11760</b>	<b>6127638</b>	<b>375790</b>	<b>6515188</b>	<b>3930348</b>

**Table 9: Ground Movement - Regional Results**

Ground Movement								
Continent	Region	Occurrence	Deaths	Injured	Affected	Homeless	Total Affected	Economic Damage ('000\$)
Africa	Eastern Africa	32	268	2354	109785	75265	187404	564570
Africa	Middle Africa	5	53	696	20615	1850	23161	7200
Africa	Northern Africa	32	20421	56693	611953	838409	1507055	11995929
Africa	Southern Africa	9	71	165	3285	0	3450	20000
Africa	Western Africa	2	292	1436	20000	0	21436	0
Americas	Caribbean	14	223971	300179	3498029	55	3798263	8075000
Americas	Central America	90	56443	163191	10545696	1932564	12641451	12138250
Americas	South America	131	155667	500255	13945268	1499330	15944853	9987886
Americas	Northern America	39	2826	13294	41714	20239	75247	41740770
Asia	Central Asia	22	189	954	264645	40597	306196	203500
Asia	Eastern Asia	220	1055406	833530	71570123	4956835	77360488	272324157
Asia	Southern Asia	218	383637	634550	36580733	7796975	45012258	26890343
Asia	South-Eastern Asia	141	40717	184317	13162198	1032702	14379217	7843704
Asia	Western Asia	94	91241	100423	6794405	1253890	8148718	27088073
Europe	Eastern Europe	55	157862	30055	1768633	970740	2769428	19431320
Europe	Northern Europe	5	1	8	4629	69	4706	84000
Europe	Southern Europe	92	118310	24235	2392148	402028	2818411	58629016
Europe	Western Europe	8	49	110	2650	200	2960	362000
Oceania	Australia & New Zealand	13	471	1726	643010	720	645456	25797344
Oceania	Melanesia	25	134	378	34525	18900	53803	10875
Oceania	Micronesia	1	0	71	0	0	71	120000
Oceania	Polynesia	3	6	25	5000	500	5525	1200
		<b>1251</b>	<b>2308035</b>	<b>2848645</b>	<b>1,62E+08</b>	<b>20841868</b>	<b>185709557</b>	<b>523315137</b>

**Table 10: Tsunami - Regional Results**

<b>Tsunami</b>								
<b>Continent</b>	<b>Region</b>	<b>Occurrence</b>	<b>Deaths</b>	<b>Injured</b>	<b>Affected</b>	<b>Homeless</b>	<b>Total Affected</b>	<b>Economic Damage ('000\$)</b>
Africa	Eastern Africa	4	312	283	109560	70	109913	230000
Africa	Middle Africa	0	0	0	0	0	0	0
Africa	Northern Africa	0	0	0	0	0	0	0
Africa	Southern Africa	0	0	0	0	0	0	0
Africa	Western Africa	0	0	0	0	0	0	0
Americas	Caribbean	0	0	0	0	0	0	0
Americas	Central America	1	185	0	0	0	0	0
Americas	South America	6	843	13064	2765106	925615	3703785	31100000
Americas	Northern America	3	88	0	0	0	0	900
Asia	Central Asia	0	0	0	0	0	0	0
Asia	Eastern Asia	15	32623	6938	428389	1620	436947	212821000
Asia	Southern Asia	4	51892	32303	1175729	493000	1701032	3309400
Asia	South-Eastern Asia	16	177411	10933	127152	540489	678574	6506600
Asia	Western Asia	0	0	0	0	0	0	0
Europe	Eastern Europe	3	2365	0	0	0	0	0
Europe	Northern Europe	0	0	0	0	0	0	0
Europe	Southern Europe	0	0	0	0	0	0	0
Europe	Western Europe	1	11	2			2	
Oceania	Australia & New Zealand	0	0	0	0	0	0	0
Oceania	Melanesia	8	2617	677	14903	0	15580	0
Oceania	Micronesia	0	0	0	0	0	0	0
Oceania	Polynesia	3	191	317	8274	0	8591	133540
		<b>64</b>	<b>268538</b>	<b>64517</b>	<b>4629113</b>	<b>1960794</b>	<b>6654424</b>	<b>254101440</b>

**Table 11: Flood - Regional Results**

Flood								
Continent	Region	Occurrence	Deaths	Injured	Affected	Homeless	Total Affected	Economic Damage ('000\$)
Africa	Eastern Africa	368	11944	3183	31875405	1734311	33612899	2072506
Africa	Middle Africa	118	1557	1985	3450223	471708	3923916	36059
Africa	Northern Africa	146	9284	20755	7552034	1681582	9254371	3150240
Africa	Southern Africa	63	1643	377	2237853	64885	2303115	1731619
Africa	Western Africa	244	3406	4556	20945572	2129889	23080017	1270587
Americas	Caribbean	143	6302	8937	4235419	193289	4437645	980484
Americas	Central America	226	47695	20116	8842509	286585	9149210	6864660
Americas	South America	492	48019	23276	61990737	3210750	65224763	34089138
Americas	Northern America	215	3005	414	12877266	52700	12930380	84979160
Asia	Central Asia	45	1680	1122	938086	28295	967503	1050450
Asia	Eastern Asia	427	6620903	838457	1978604854	45838694	2025282005	268989659
Asia	Southern Asia	732	160166	146101	1240853869	31538502	1272538472	102827090
Asia	South-Eastern Asia	590	23075	261769	156959857	2036581	159258207	63027088
Asia	Western Asia	149	4297	1203	5135333	862770	5999306	6830776
Europe	Eastern Europe	221	3433	10372	8788537	318057	9116966	28677078
Europe	Northern Europe	47	114	8	416865	30000	446873	23310030
Europe	Southern Europe	193	3342	17376	4473031	1573812	6064219	41089759
Europe	Western Europe	123	2457	188	1037792	200	1038180	45157896
Oceania	Australia & New Zealand	98	350	87	336639	7400	344126	14826000
Oceania	Melanesia	34	206	2	836047	100000	936049	294875
Oceania	Micronesia	5	0	0	1180	85	1265	0
Oceania	Polynesia	2	6	3	0	0	3	51500
		<b>4681</b>	<b>6952884</b>	<b>1360287</b>	<b>3552389108</b>	<b>92160095</b>	<b>3645909490</b>	<b>731306654</b>



**Table 12: Landslide - Regional Results**

Landslide								
Continent	Region	Occurrence	Deaths	Injured	Affected	Homeless	Total Affected	Economic Damage ('000\$)
Africa	Eastern Africa	20	758	137	20141	16142	36420	0
Africa	Middle Africa	8	410	7	1248	1596	2851	0
Africa	Northern Africa	2	16	46	10000	2866	12912	0
Africa	Southern Africa	1	34	0	0	0	0	0
Africa	Western Africa	6	82	23	480	11800	12303	0
Americas	Caribbean	7	443	60	1375	1000	2435	0
Americas	Central America	27	3879	157	9957	51220	61334	505000
Americas	South America	132	15240	4743	5265956	188890	5459589	2366727
Americas	Northern America	5	658	15	125	150	290	20000
Asia	Central Asia	22	686	43	90450	75052	165545	252200
Asia	Eastern Asia	105	7283	2155	2484317	31489	2517961	3167890
Asia	Southern Asia	125	9696	1350	1010428	3708485	4720263	90500
Asia	South-Eastern Asia	105	5619	1158	807219	136477	944854	181326
Asia	Western Asia	18	646	245	10924	2385	13554	26000
Europe	Eastern Europe	17	12731	8	800	2830	3638	423000
Europe	Northern Europe	7	276	70	63	0	133	16789
Europe	Southern Europe	19	2764	362	14113	5735	20210	1395510
Europe	Western Europe	29	891	26	14431	60	14517	1273590
Oceania	Australia & New Zealand	3	28	1	700	0	701	2466
Oceania	Melanesia	12	495	40	1063	18000	19103	0
Oceania	Micronesia	0	0	0	0	0	0	0
Oceania	Polynesia	3	23	11	500	0	511	0
		<b>673</b>	<b>62658</b>	<b>10657</b>	<b>9744290</b>	<b>4254177</b>	<b>14009124</b>	<b>9720998</b>

**Table13: Extreme Temperature - Regional Results**

Extreme Temperature								
Continent	Region	Occurrence	Deaths	Injured	Affected	Homeless	Total Affected	Economic Damage ('000\$)
Africa	Eastern Africa	0	0	0	0	0	0	0
Africa	Middle Africa	0	0	0	0	0	0	0
Africa	Northern Africa	10	236	284	757500	0	757784	809
Africa	Southern Africa	3	63	20	0	0	20	0
Africa	Western Africa	3	78	0	1000000	0	1000000	47000
Americas	Caribbean	0	0	0	0	0	0	0
Americas	Central America	23	1195	0	132634	16000	148634	584850
Americas	South America	49	2636	1824867	3722878	5247	5552992	2189000
Americas	Northern America	41	5711	31	200	0	231	18085000
Asia	Central Asia	8	31	62	2607500	0	2607562	840000
Asia	Eastern Asia	30	1218	116003	82731286	233000	83080289	23219200
Asia	Southern Asia	111	25085	3234	887952	0	891186	562133
Asia	South-Eastern Asia	2	77	0	1000000	0	1000000	0
Asia	Western Asia	16	181	962	20000	0	20962	951000
Europe	Eastern Europe	98	62924	22240	947974	0	970214	1665450
Europe	Northern Europe	20	1256	47	0	0	47	0
Europe	Southern Europe	60	40970	1016	416078	1340	418434	6659901
Europe	Western Europe	52	39737	365	10000	0	10365	7862000
Oceania	Australia & New Zealand	7	509	2784	4600000	0	4602784	200000
Oceania	Melanesia	0	0	0	0	0	0	0
Oceania	Micronesia	0	0	0	0	0	0	0
Oceania	Polynesia	0	0	0	0	0	0	0
		<b>533</b>	<b>181907</b>	<b>1971915</b>	<b>98834002</b>	<b>255587</b>	<b>101061504</b>	<b>62866343</b>

**Table 14: Fog - Regional Results**

Fog								
Continent	Region	Occurrence	Deaths	Injured	Affected	Homeless	Total Affected	Economic Damage ('000\$)
Africa	Eastern Africa	0	0	0	0	0	0	0
Africa	Middle Africa	0	0	0	0	0	0	0
Africa	Northern Africa	0	0	0	0	0	0	0
Africa	Southern Africa	0	0	0	0	0	0	0
Africa	Western Africa	0	0	0	0	0	0	0
Americas	Caribbean	0	0	0	0	0	0	0
Americas	Central America	0	0	0	0	0	0	0
Americas	South America	0	0	0	0	0	0	0
Americas	Northern America	0	0	0	0	0	0	0
Asia	Central Asia	0	0	0	0	0	0	0
Asia	Eastern Asia	0	0	0	0	0	0	0
Asia	Southern Asia	0	0	0	0	0	0	0
Asia	South-Eastern Asia	0	0	0	0	0	0	0
Asia	Western Asia	0	0	0	0	0	0	0
Europe	Eastern Europe	0	0	0	0	0	0	0
Europe	Northern Europe	1	4000	0	0	0	0	0
Europe	Southern Europe	0	0	0	0	0	0	0
Europe	Western Europe	0	0	0	0	0	0	0
Oceania	Australia & New Zealand	0	0	0	0	0	0	0
Oceania	Melanesia	0	0	0	0	0	0	0
Oceania	Micronesia	0	0	0	0	0	0	0
Oceania	Polynesia	0	0	0	0	0	0	0
		<b>1</b>	<b>4000</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>

**Table 15: Storm - Regional Results**

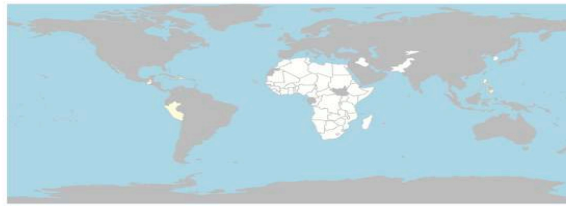
Storm								
Continent	Region	Occurrence	Deaths	Injured	Affected	Homeless	Total Affected	Economic Damage ('000\$)
Africa	Eastern Africa	141	4574	9273	13045876	1796459	14851608	3200693
Africa	Middle Africa	20	95	3010	101416	37791	142217	282
Africa	Northern Africa	21	341	305	174707	0	175012	1202050
Africa	Southern Africa	38	330	1340	1272831	20080	1294251	818193
Africa	Western Africa	29	577	606	119900	41360	161866	8900
Americas	Caribbean	312	31259	19611	21588232	2083233	23691076	33866748
Americas	Central America	197	41255	23900	15085979	775622	15885501	42960376
Americas	South America	86	1820	4223	1645756	223557	1873536	766050
Americas	Northern America	647	31103	14772	13692600	440927	14148299	621596280
Asia	Central Asia	5	116	0	9905	1500	11405	3434
Asia	Eastern Asia	669	243718	212026	492190853	15635533	508038412	176536391
Asia	Southern Asia	413	813747	962854	173582316	20458613	195003783	28089852
Asia	South-Eastern Asia	514	216935	104527	207803703	11208474	219116704	33089081
Asia	Western Asia	50	547	8893	3422073	11500	3442466	5593050
Europe	Eastern Europe	84	960	1745	2740965	35417	2778127	2045600
Europe	Northern Europe	93	457	116	1107780	0	1107896	23349539
Europe	Southern Europe	74	663	276	606110	13446	619832	9683900
Europe	Western Europe	220	1318	1372	4336490	800	4338662	67644706
Oceania	Australia & New Zealand	116	296	1017	4089582	16662	4107261	19692904
Oceania	Melanesia	103	1355	1546	2089895	133607	2225048	1657536
Oceania	Micronesia	22	82	731	56794	23277	80802	1018645
Oceania	Polynesia	65	448	382	563167	82407	645956	1043579
		<b>3919</b>	<b>1391996</b>	<b>1372525</b>	<b>959326930</b>	<b>53040265</b>	<b>1013739720</b>	<b>1073867789</b>

## Appendix II

1 Biological Total Deaths



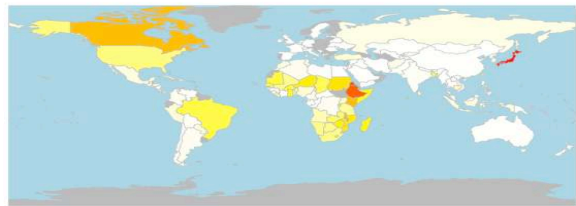
2a Biological Injured



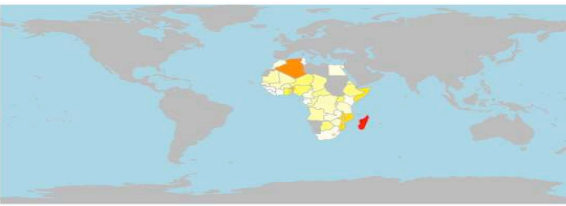
2b Biological Injured



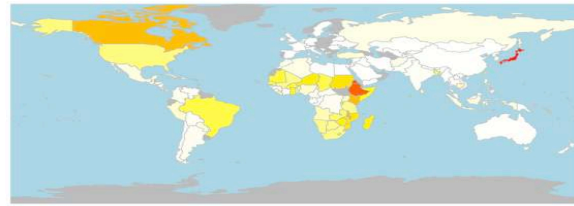
3 Biological Affected



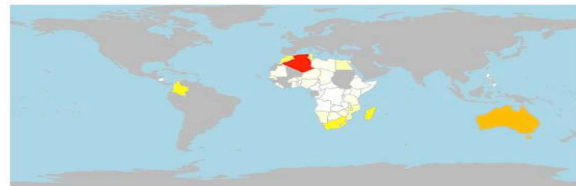
4 Biological Homeless



5 Biological Total Affected



6 Biological Total Damage



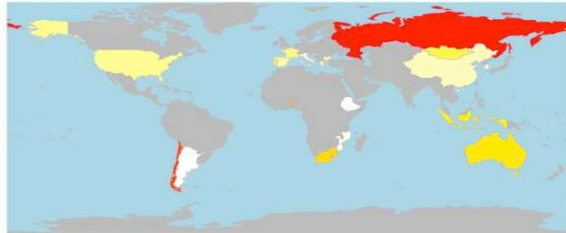
7

Climatological Total Deaths



8

Climatological Injured



9

Climatological Affected



10

Climatological Homeless



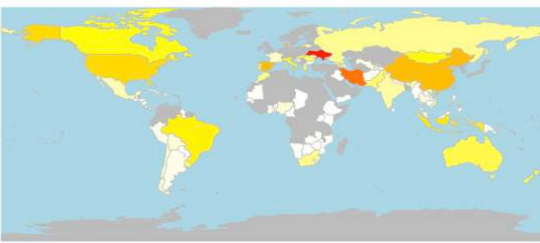
11

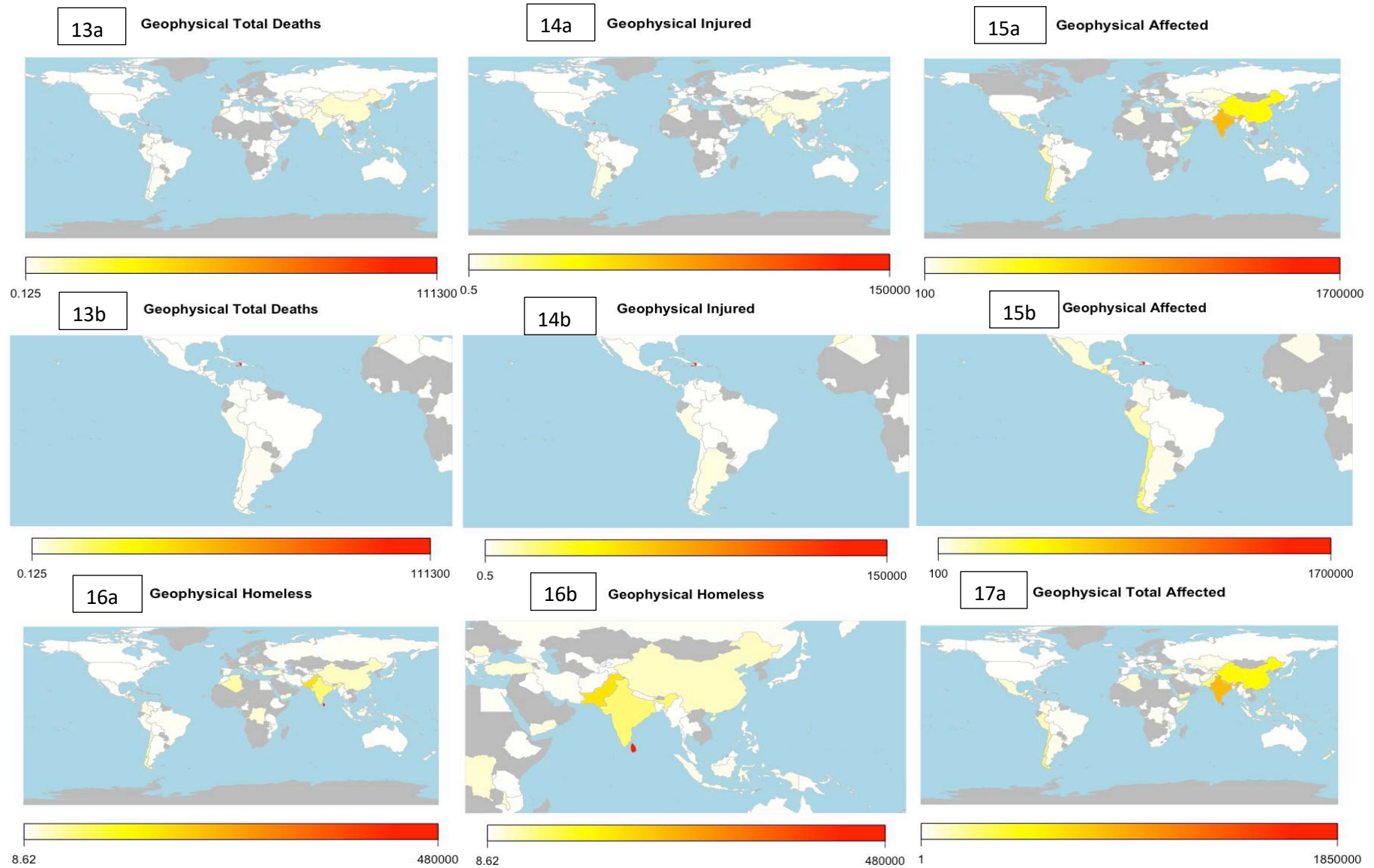
Climatological Total Affected



12

Climatological Total Damage





17b

Geophysical Total Affected



18

Geophysical Total Damage





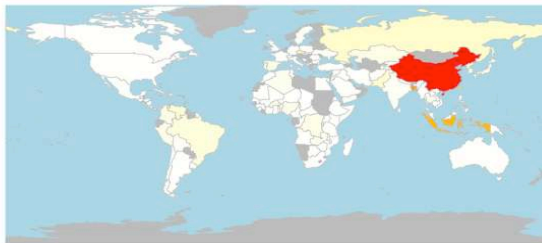
19

Hydrological Total Deaths



20

Hydrological Injured



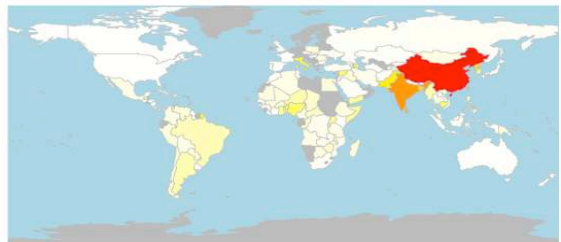
21

Hydrological Affected



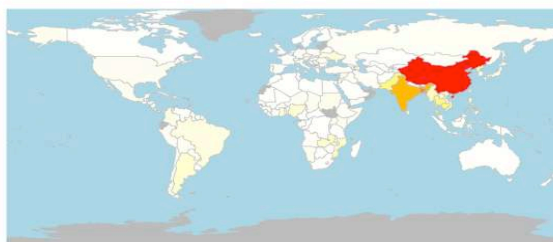
22

Hydrological Homeless



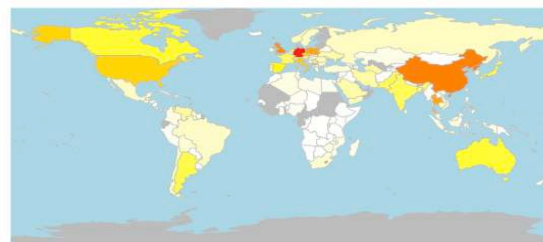
23

Hydrological Total Affected



24

Hydrological Total Damage



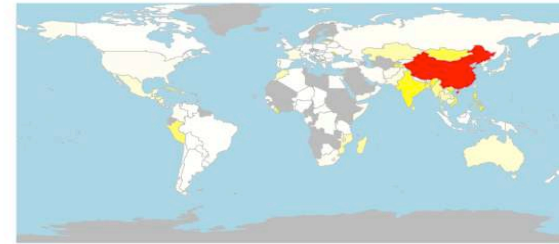
25 Meteorological Total Deaths



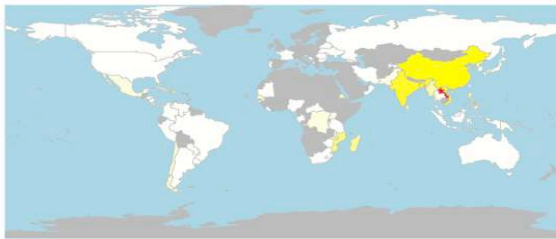
26 Meteorological Injured



27 Meteorological Affected



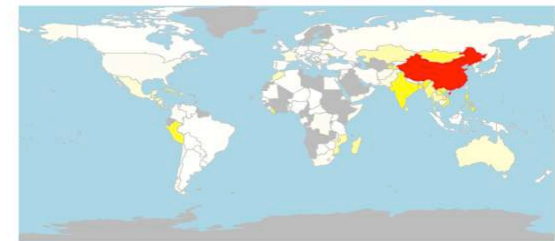
28a Meteorological Homeless



28b Meteorological Homeless



29 Meteorological Total Affected



30 Meteorological Total Damage

